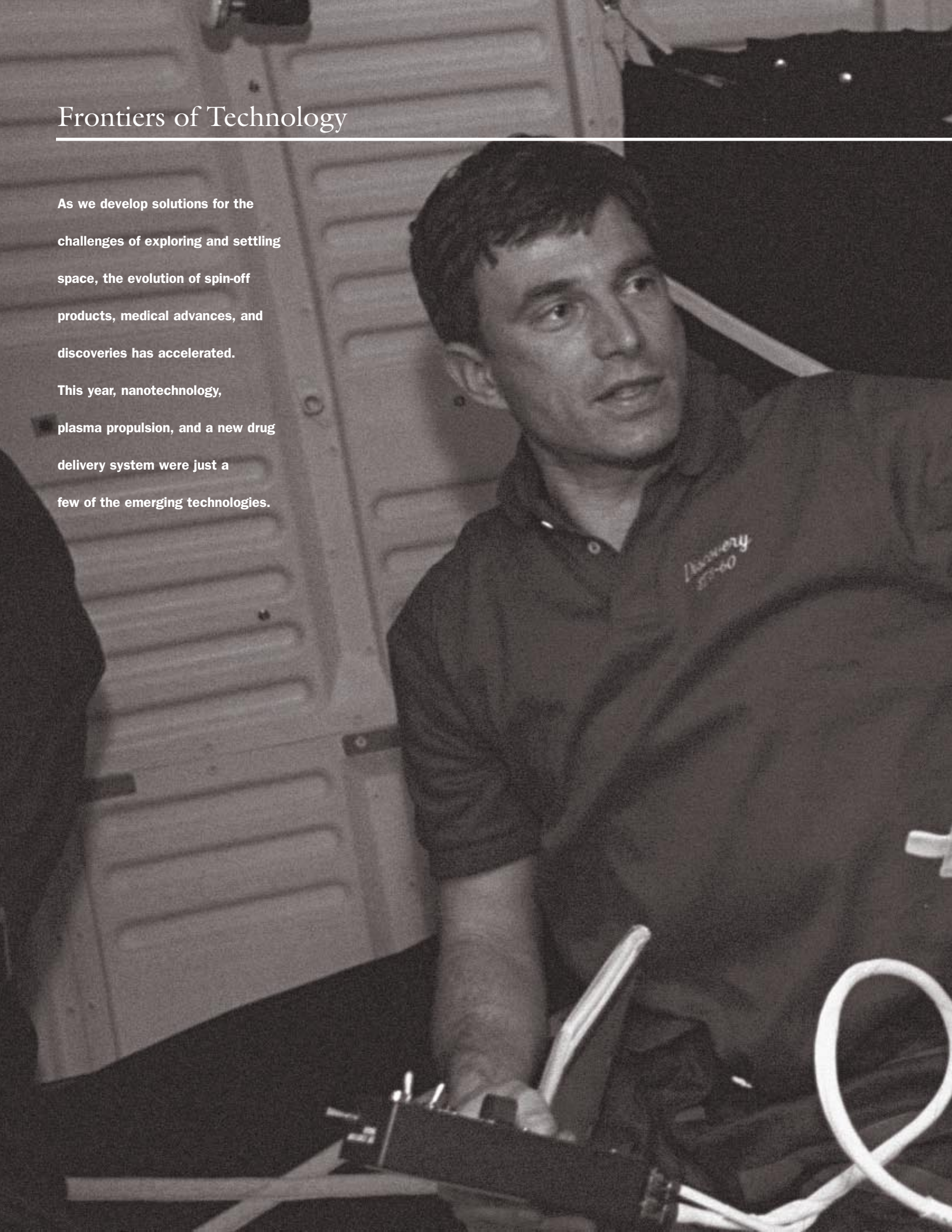
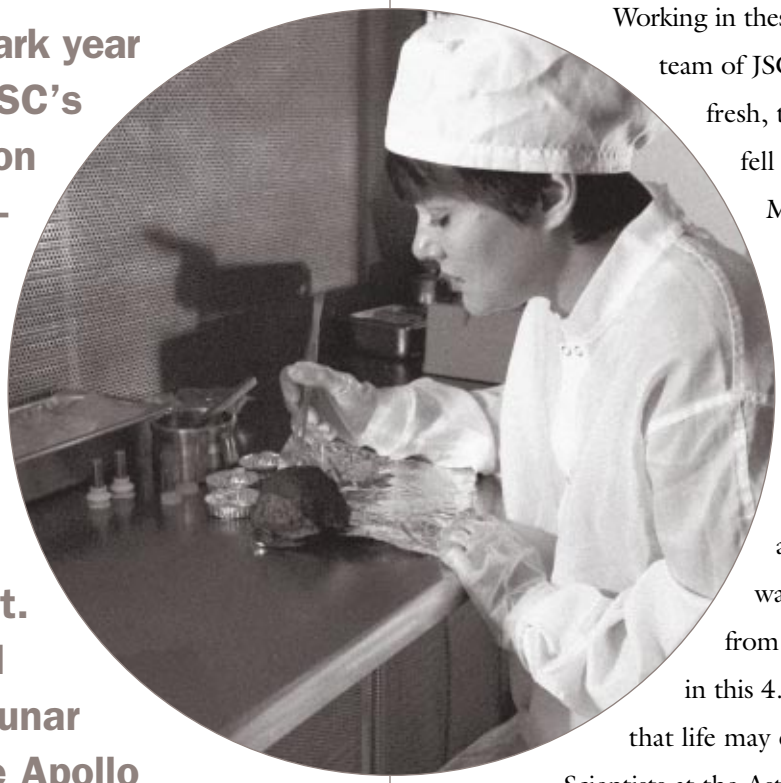
Frontiers of Technology

As we develop solutions for the challenges of exploring and settling space, the evolution of spin-off products, medical advances, and discoveries has accelerated. This year, nanotechnology, plasma propulsion, and a new drug delivery system were just a few of the emerging technologies.



In 1999, the unique capabilities of JSC produced more answers about the essence of life and the nature of the universe as well as down-to-earth advances in the field of medicine and human health. Highlights ranged from discoveries in meteorites that hint of life beyond our planet to advances that improve the quality of life today on Earth.

It's been a landmark year for the team at JSC's Meteorite Curation Lab. Major breakthroughs include discoveries of water in ancient meteorites which suggest life may exist beyond our planet. This one-of-a-kind lab also houses lunar samples from the Apollo flights and will soon coordinate handling of Mars samples and samples of solar wind.



Astromaterials

JSC is the location of America's Astromaterials Curation Facility, NASA's home for extraterrestrial materials. This unique facility houses the Lunar Sample Laboratory, the Antarctic Meteorite Laboratory, and the Cosmic Dust Laboratory. Here, researchers work in full smocks ("bunny suits"), caps, and gloves and take an air shower before entering the pristine labs.

Working in these clean-room conditions, a team of JSC scientists began analyzing a fresh, three-day-old meteorite that fell to Earth in March 1998 in Monahans, Texas. They found halite crystals (table salt) inside which contained microscopic bubbles of water. This marked the first time — after searching for generations — that anyone had found liquid water in an object recovered from space. The presence of water in this 4.5-billion-year-old rock hints that life may exist outside our planet.

Scientists at the Astromaterials Curation Facility also laid the foundation for preserving and studying the next generation of extraterrestrial specimens. They prepared new facilities to receive samples that will be brought back from NASA's upcoming sample-retrieving missions to Mars, the first scheduled for 2003, and samples of solar wind to be brought back from the Genesis mission scheduled for 2001.

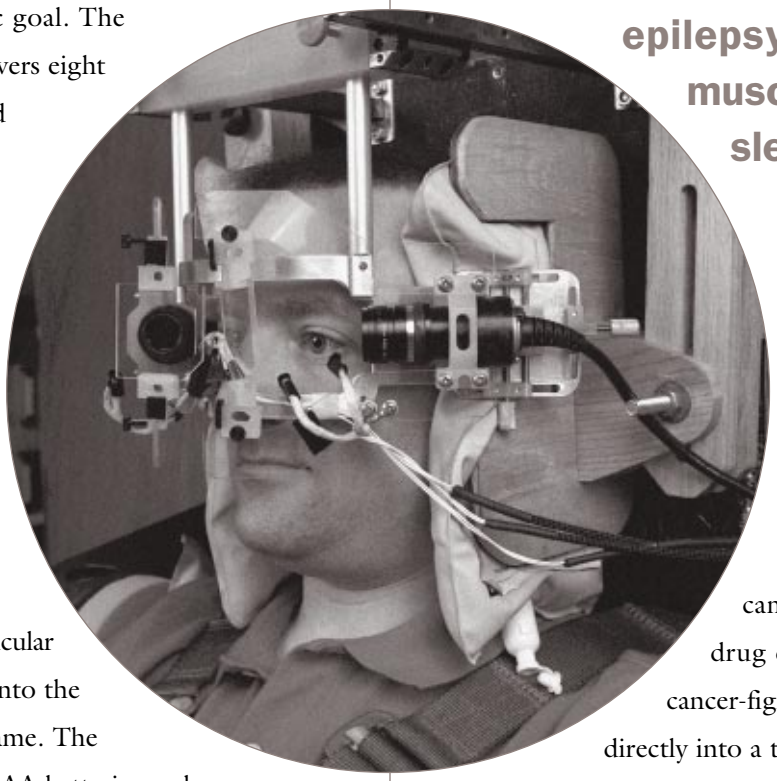
Meteorite Curation Laboratory
You only get one chance to curate and preserve the integrity of "rock" samples so carefully collected from space, and JSC's Meteorite Curation Lab makes sure it's done right.

Biomedical Research

The National Space Biomedical Research Institute (NSBRI), a JSC cooperative partnership managed by Baylor College of Medicine and including 12 other prominent research institutions, completed its second year of study. The NSBRI is responsible for the development of countermeasures against the damaging effects of long-duration space flight and for fundamental and applied space biomedical research directed toward this specific goal. The current research program covers eight disciplines and is conducted by 130 investigators at 27 institutions and government laboratories. More than 250 published papers and books have resulted from the vigorous research activities initiated by the NSBRI.

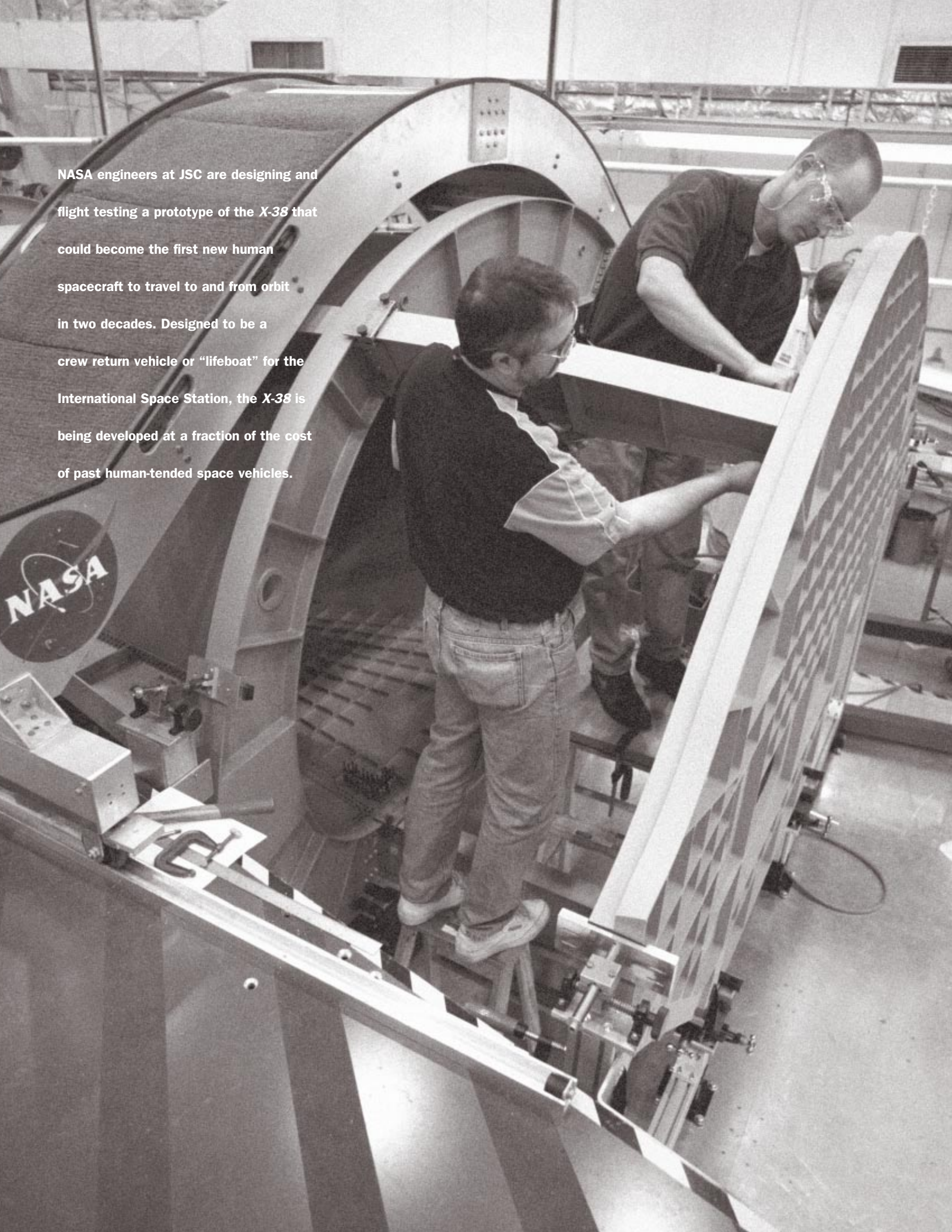
In another area of medical research at JSC, a tiny heart pump, called the NASA/DeBakey VAD (ventricular assist device), was inducted into the Space Technology Hall of Fame. The pump is no bigger than two AA batteries and one-tenth the size of portable heart-assist devices now on the market. Development of this breakthrough required a broad range of skills, both from the NASA team and from Dr. Michael DeBakey and his staff at the Baylor College of Medicine. The pump, used as a bridge device before heart transplants, has been successfully implanted in at least 20 patients to date. About half have gone on to receive heart transplants. NASA holds the patent on the device, which is being successfully developed and marketed by a local start-up company.

In April 1999, preliminary findings were released from the 1998 "Neurolab" mission that increased our understanding of how the human brain performs in space. New answers were revealed for Alzheimer's Disease, epilepsy, brain injuries, muscle atrophy, and sleep deprivation.



Hope for the war on cancer came in the form of a new drug delivery system that allows cancer-fighting drugs to be injected directly into a tumor for sustained release. NASA and Houston's Institute for Research have jointly developed and copatented the new technology for tiny microcapsules, slightly larger than white blood cells and similar to water balloons, that can be injected into an artery leading into a large, solid tumor. With the microcapsules, cancer patients do not have to endure the debilitating side effects of having the anticancer drug circulating throughout their systems. Furthermore,

Biomedical Research
In 1998, a crew of seven astronauts dedicated themselves to furthering our knowledge of the central nervous system by supporting 26 experiments in an ambitious Space Shuttle mission called Neurolab. A preliminary report came back in 1999.



NASA engineers at JSC are designing and flight testing a prototype of the *X-38* that could become the first new human spacecraft to travel to and from orbit in two decades. Designed to be a crew return vehicle or "lifeboat" for the International Space Station, the *X-38* is being developed at a fraction of the cost of past human-tended space vehicles.

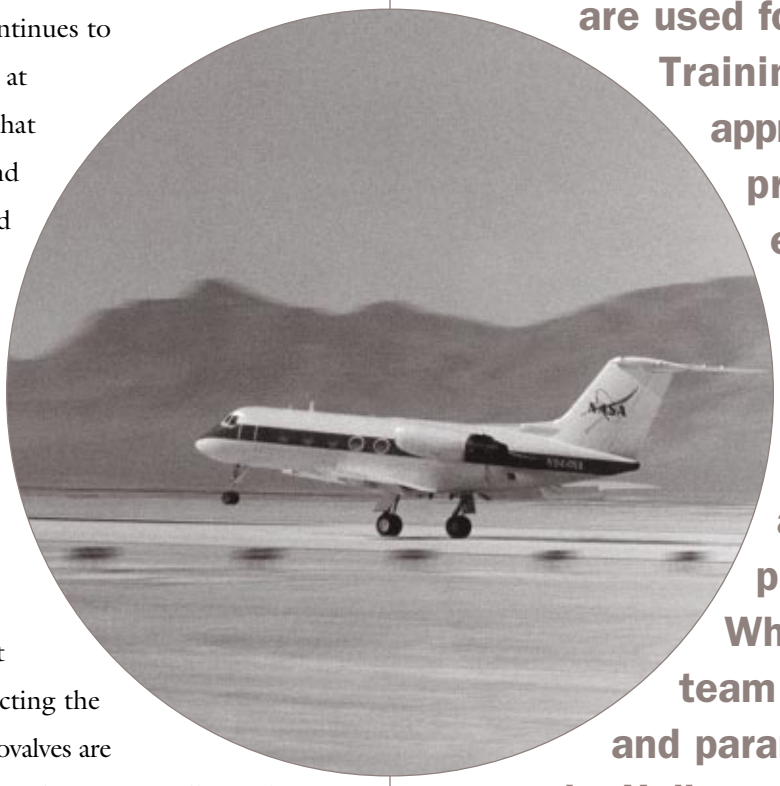
because the tumor is treated directly, only a tiny fraction of the dose required for systemic treatment is required.

Researchers use the weightless environment of space to produce these capsules. Microencapsulation experiments have been flown on nine Shuttle flights, and anticlotting enzymes, antinausea drugs and antibiotics have also been successfully microencapsulated in space.

Technology

Technology development continues to be a dynamic area of growth at Johnson Space Center, one that demonstrates the diversity and uniqueness of its facilities and the high caliber of its teams.

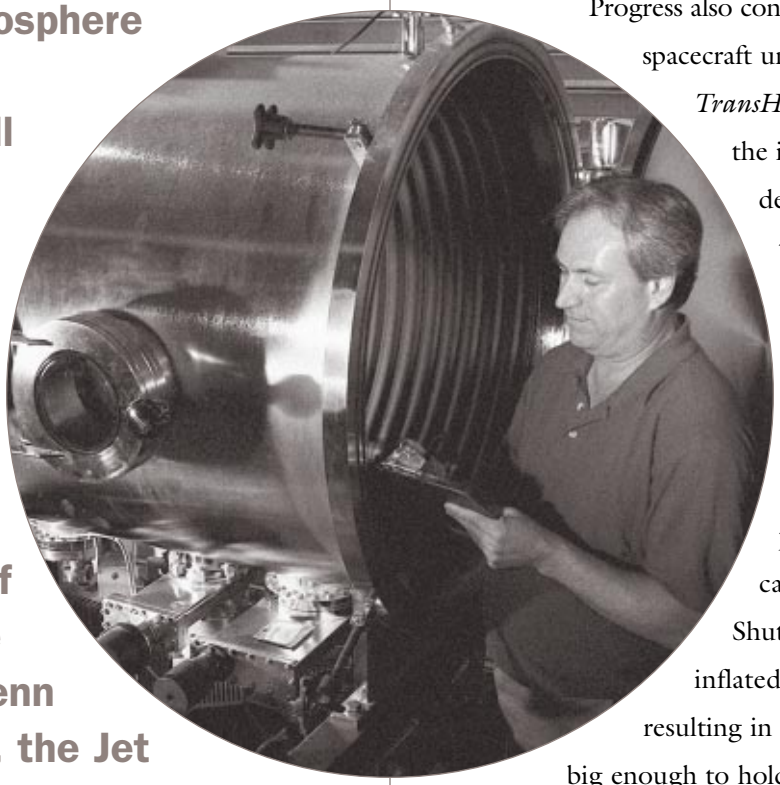
One of JSC's sophisticated research and testing sites is the White Sands Test Facility in Las Cruces, New Mexico, home to a 650-person workforce and a leading center of propulsion technology. One of its recent areas of focus has been perfecting the technology of pyrovalves. Pyrovalves are explosive-actuated, one-time-use devices typically used to begin liquid or gas flow in spacecraft systems, usually after some time of dormancy. They are crucial components for vehicles sent into deep space, which may need to activate propellant and helium pressurization systems after years of inactivity in extreme environments.



While its identity is unknown to many outside the area, the dedication of the team at White Sands Space Harbor, a branch of JSC's White Sands Test Facility, is not. They maintain three laser-level runways in the desert which are used for the Shuttle Training Aircraft approach and landing practice and can even serve as an alternative landing site for Shuttle missions such as STS-3. The professionals at White Sands also team with firefighters and paramedics from nearby Holloman Air Force Base to support training missions with emergency safety procedures.

The White Sands Space Harbor
Shuttle Training Aircraft performing typical training approach.

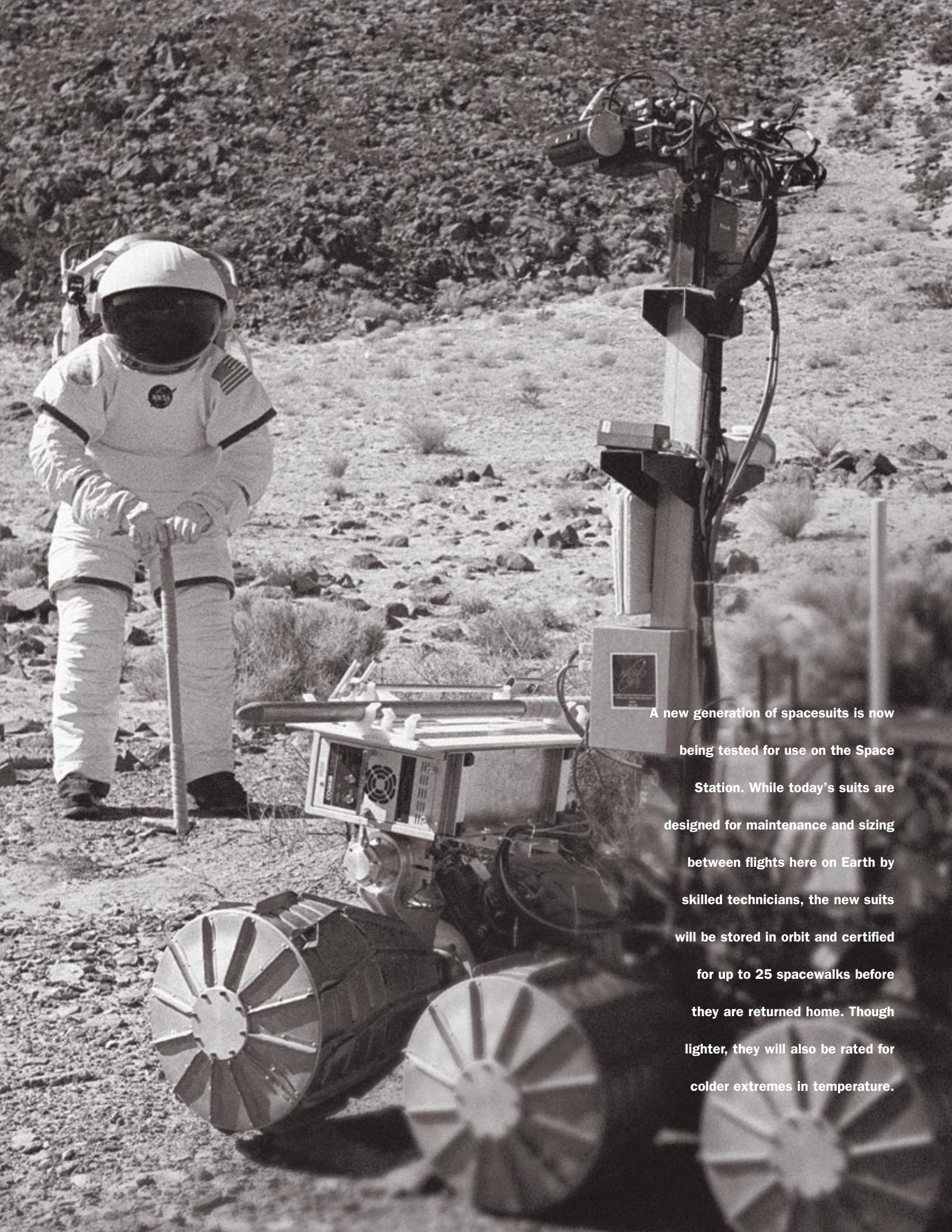
They are a very down-to-earth group, but for the last 2 years, a NASA team led by Project Manager Jim Ratliff has been working on a device called the Mars In-situ Propellant Production Precursor, which successfully turned Martian-like atmosphere into oxygen. The device, which will be carried to the planet aboard the Mars Surveyor 2001, will perform five experiments on Mars. Designers and developers of the project come from JSC, the Glenn Research Center, the Jet Propulsion Lab, and the University of Arizona.



At the JSC campus in Houston, Texas, progress continued on the development of the *X-38* Crew Return Vehicle, an innovative spacecraft designed to be a "lifeboat" for the International Space Station. It marks the first time a prototype spacecraft has ever been built at JSC. With an eye for efficiency, the *X-38* uses available equipment and developed technology in as much as 80 percent of its design.

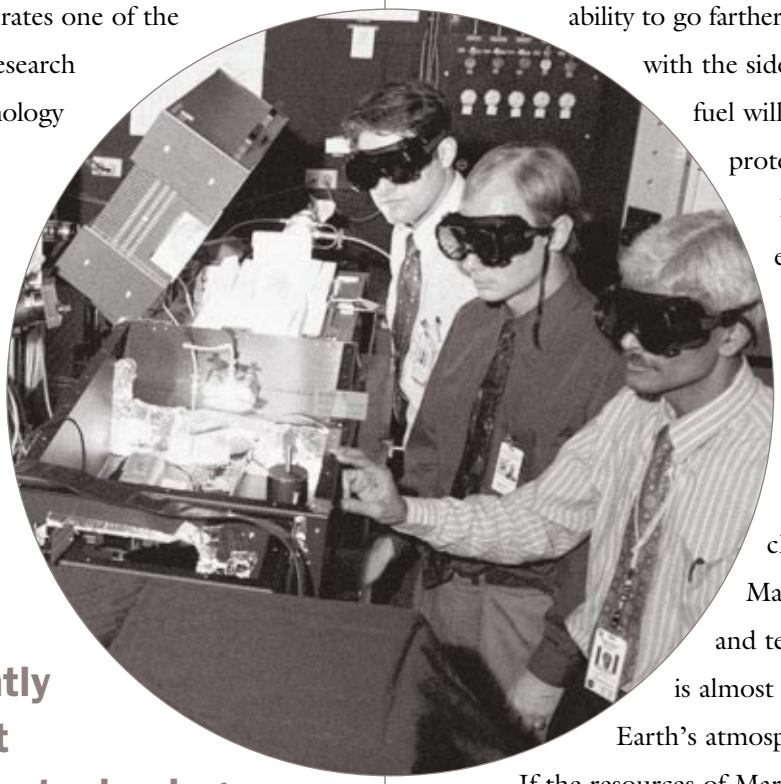
Progress also continued on another important spacecraft under development, the *TransHab*. A full-scale model of the inflatable *TransHab* was deployed and successfully tested in the Center's Space Simulation Chamber. In less than a year, an internal team of engineers at JSC designed and fabricated the three-story-tall prototype. It would be carried aboard the Space Shuttle, deployed in space, and inflated to its operational pressure, resulting in a 27-foot-diameter module, big enough to hold an entire ISS crew and a changeover crew at the same time. The huge *TransHab* prototype first underwent two successful tests in JSC's Neutral Buoyancy Lab, demonstrating the structural integrity of its outside fabric structure to a safety factor of four atmospheres (no aluminum space module has done this).

Mars Environment Chamber
In a unique lab that recreates the thin, cold atmosphere of Mars, JSC scientists were able to successfully manufacture oxygen.



A new generation of spacesuits is now being tested for use on the Space Station. While today's suits are designed for maintenance and sizing between flights here on Earth by skilled technicians, the new suits will be stored in orbit and certified for up to 25 spacewalks before they are returned home. Though lighter, they will also be rated for colder extremes in temperature.

In materials science, the development of nanotechnology at JSC represents potentially huge technological advancements in one of the world's smallest packages. Carbon nanotubes, or fullerene fibers, are microscopic fibers a billionth of a meter in diameter. They exhibit electrical conductivity as high as that of copper and thermal conductivity as high as that of a diamond, and they are potentially 30 to 100 times stronger than steel at one-sixth its weight. JSC operates one of the world's few comprehensive research facilities devoted to nanotechnology and is a collaborative partner with Rice University's Nobel Prize-winning team.



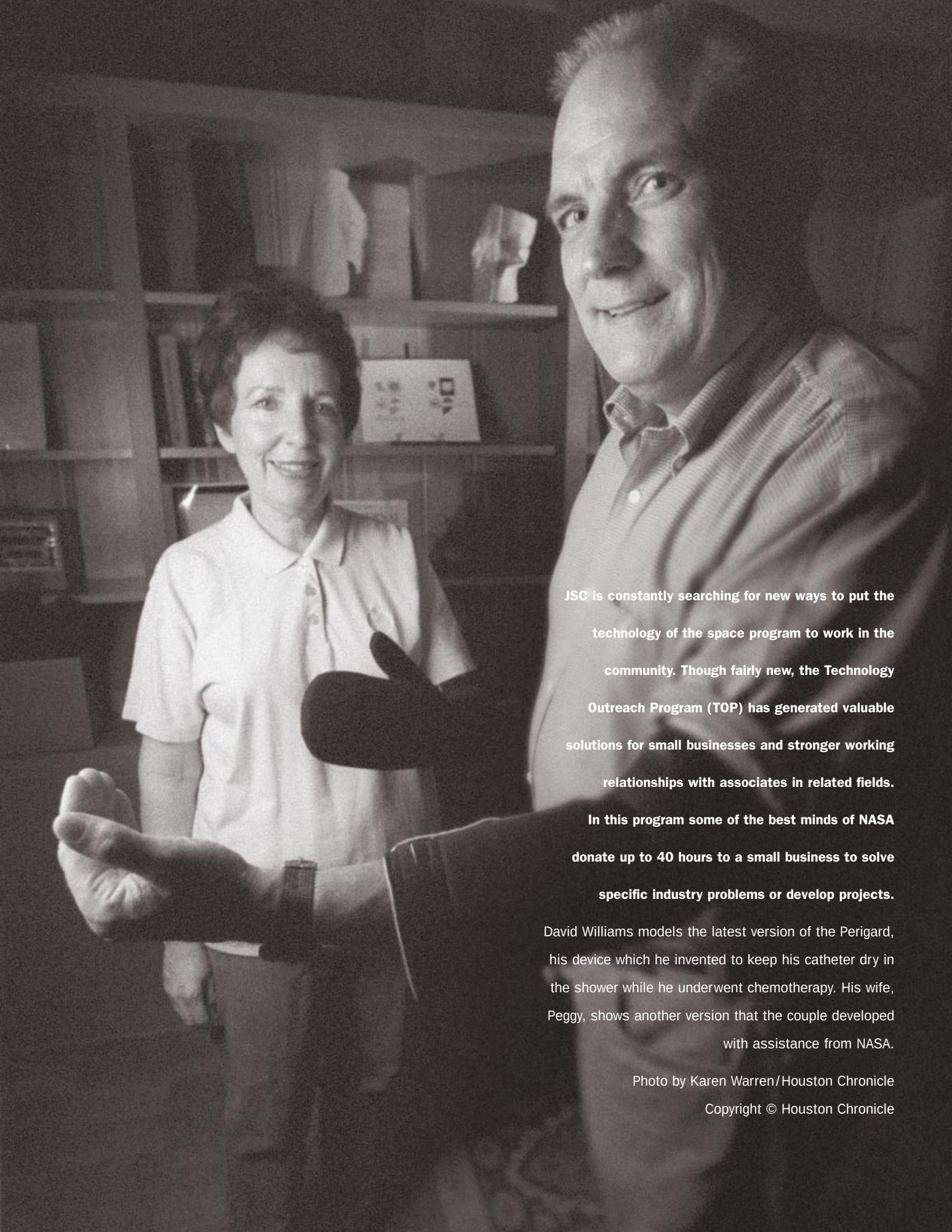
With researchers from Rice University as our partners, NASA scientists at JSC are currently making important discoveries in nanotechnology, which involves tubular microscopic fibers a billionth of a meter in diameter.

On a different front, a team of 20 veteran scientists and engineers at JSC and student researchers made exciting strides in the field of advanced space propulsion with their work with "the fourth state of matter," plasma. Although relatively scarce on Earth, appearing as the glowing material inside flames and lightning, plasma makes up 99 percent of the universe, including the sun and stars. This new propulsion technology promises faster space travel and the ability to go farther with increased load capacity, with the side benefit that the hydrogen fuel will offer effective radiation protection for astronauts.

Looking ahead, JSC engineers successfully tested a device that can produce oxygen out of the thin air on Mars. The Mars In-situ Propellant Production device was tested in a chamber that simulated Martian atmospheric pressures and temperatures. The Mars mix is almost 150 times thinner than Earth's atmosphere and much colder.

If the resources of Mars can be used to produce oxygen for breathing and propellants, it could greatly reduce the mass of materials needed to support a human mission to our closest neighboring planet.

Nanotube Development
William Holmes, Brad Files, and Sivaram Arepalli work in the nanotube production laboratory. Though the fibers measure less than a billionth of a meter in diameter, scientists know they are potentially 30 to 100 times stronger than steel, with one-sixth of the weight.



JSC is constantly searching for new ways to put the technology of the space program to work in the community. Though fairly new, the Technology Outreach Program (TOP) has generated valuable solutions for small businesses and stronger working relationships with associates in related fields. In this program some of the best minds of NASA donate up to 40 hours to a small business to solve specific industry problems or develop projects.

David Williams models the latest version of the Perigard, his device which he invented to keep his catheter dry in the shower while he underwent chemotherapy. His wife, Peggy, shows another version that the couple developed with assistance from NASA.

Photo by Karen Warren/Houston Chronicle